FOUR-YEAR UNDER GRADUATE

PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**BASIC INORGANIC AND NANO CHEMISTRY**				
Type of Course	**MINOR**				
Semester	**I**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Concept of atom and molecule Constituents of the atom, Rutherford's model of the atom. Periodic table and classification of elements to different blocks, Basic knowledge of qualitative and quantitative analysis Titration and use of indicators				
Course Summary	This course is intended to provide basic knowledge in inorganic chemistry and nanochemistry. The student gets an understanding of the Bohr model of the atom and the modern quantum mechanical model of the atom through the first module of this course. Different types of chemical bonding are also included in the first module. General properties of the atom and the variation of these properties in the periodic table are also discussed in this course. Basic principles of analytical chemistry are included in the third module of this course which includes acid-base titration, redox titration, complexometric titration, and mixture analysis. This course also tries to explore the basic principles and importance of nanochemistry. To master the laboratory skills acid-base titration, and redox titration experiments are incorporated into this course structure.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	**To Understand the structure of atoms and rules regarding the arrangement of electrons in an atom.**	U	C	Instructor-created exams / Quiz /Assignment
CO2	**To discuss the chemical bonding, theories of chemical bonding and predict molecular shapes using VSEPR theory**	U	F	Instructor-created exams / Quiz /Assignment

CO3	**To Comprehend periodic properties, understand laws and the concept of the modern periodic table, and its implications**	U	F	Instructor-created exams / Quiz /Assignment
CO4	**To Master the principle of volumetric analysis, understand the separation of cations in qualitative analysis**	U	C	Instructor-created exams / Quiz /Assignment
CO5	**To understand the basics of Nano chemistry & to describe the synthesis of nanomaterials, carbon nanotubes, and their applications,**	U	F	Instructor-created exams / Quiz /Assignment
CO6	**To Perform different titrations and execute open-ended experiments safely and effectively**	Ap	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Mark
I		**Atomic structure and Chemical Bonding**	**15**	**34**
	1	Bohr atom model, merits and its limitations, Heisenberg uncertainty principle, Louis de Broglie's matter waves – dual nature.	2	
	2	Schrödinger wave equation (Mention the equation and the terms in it), - Concept of orbitals, comparison of orbit and orbital.	2	
	3	Quantum numbers and their significance	1	
	4	Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms.	2	
	5	Chemical Bonding: Introduction – Type of bonds. Ionic bond, Covalent bond, Coordinate bond, and hydrogen bond (Intermolecular and intramolecular hydrogen bond with examples).	2	
	6	VSEPR theory: Shapes of $BeCl_2$, BF_3, CH_4, NH_3, H_2O, PCl_5, SF_4, ClF_3, XeF_2, SF_6, IF_5, XeF_4, IF_7 and XeF_6. NH_4^+, SO_4^{2-}	2	
	7	Valence Bond theory - Hybridisation involving s, p and d orbitals: SP (acetylene), SP^2 (ethylene), SP^3 (CH_4), SP^3d (PCl_5), SP^3d^2 (SF_6)	2	

	8	Molecular Orbital theory: LCAO – Electronic configuration of H_2, B_2, C_2, N_2, O_2 and CO – Calculation of bond order and its applications.(Bond length and bond strength), Comparison of VB and MO theories	2	
II		**Periodic Properties**	**5**	**10**
	9	Name and symbol of elements, Law of triads, octaves, X-ray studies of Henry Mosley, Moseley's periodic law - Modern periodic law – Long form periodic table.	**2**	
	10	Periodicity in properties: Atomic and ionic radii, Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity, valency, Oxidation number (Representative element), metallic and non-metallic character, inert pair effect,	**3**	
III		**Analytical Chemistry**	**15**	**34**
	11	Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Equivalent mass.	**2**	
	12	Methods of expressing concentration: Molality, molarity, normality, ppm, and mole fraction.	**2**	
	13	Dilution formula, Theory of volumetric analysis – Acid-base, redox, and complexometric titrations :	**3**	
	14	acid-base, redox, and complexometric indicators. Double burette method of titration: Principle and advantages.	**2**	
	15	Principles in the separation of cations in qualitative analysis	**2**	
	16	Common ion effect and solubility product and its applications in qualitative analysis	**2**	
	17	Microanalysis and its advantages. Accuracy & Precision (mention only).	**2**	
IV		**Nano Chemistry**	**10**	**20**
	18	Introduction, Definition of nanomaterials and nanotechnology –Classification of nanomaterials based on dimension with examples for each 0D, 1D, and 2D	**2**	
	19	Synthesis of nanomaterials: top-down processes and Bottom–up processes	**2**	
	20	Carbon nanotubes, Types of Carbon nanotubes – SWCNT and MWCNT, Synthesis of Carbon nanotubes - electric arc discharge, laser ablation, and chemical vapor deposition.	**3**	

	21	Important properties of carbon nanotubes and applications of carbon nanotubes.	**1**	
	22	Fullerenes, graphene - (basic concept only, no classification is required) Applications of nanomaterials.	**2**	
V		**Basic Inorganic Chemistry Practical:** **Acid-Base titrations and Redox titrations**	**30**	
		General Instructions For weighing electronic balance must be used. For titrations, double burette titration method should be used. Standard solution must be prepared by the student. Use a safety coat, gloves, shoes and goggles in the laboratory. A minimum of 7 experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher		
		Importance of lab safety – Burns, Eye accidents, Cuts, gas poisoning, Electric shocks, Treatment of fires, Precautions and preventive measures. Weighing using electronic balance, Preparation of standard solutions.		
	I	**Neutralization Titrations** 1. Strong acid – strong base. 2. Strong acid – weak base. **3.** Weak acid – strong base.		
	II	**Redox Titrations - Permanganometry:** 4. Estimation of oxalic acid. 5. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt **Redox Titrations - Dichrometry** 6. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using internal indicator. 7. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using external indicator. **Redox Titrations - Iodimetry and Iodometry:** 8. Estimation of iodine. **9.** Estimation of copper		
	III	**Open-ended experiments - Suggestions** Iodometry: Estimation of chromium. Determination of acetic acid content in vinegar by titration with NaOH. Determination of alkali content in antacid tablets by titration with HCl. Determination of available chlorine in bleaching powder.		

References

1. C. N. R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.

2. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edn., Tata McGraw Hill Publishing Company, Noida, 2007.

3. R. Puri, L. R. Sharma K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.

4. Satya Prakash, *Advanced Inorganic Chemistry*, Vol. 1, 5th Edn., S. Chand and Sons, New Delhi, 2012.

5. W. U. Malik, G. D. Tuli, R. D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010.

6. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Oxford University Press, New Delhi, 2008.

7. M. A. Shah, Tokeer Ahmad, *Principles of Nanoscience and Nanotechnology*, Narosa Publishing House, New Delhi, 2010.

8. T. Pradeep, *A Textbook of Nanoscience and Nanotechnology*, McGrawhill, New Delhi, 2012.

9. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.

10. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edn., Prentice Hall, New Delhi, 1996.

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2				2		1				1		
CO 2	2				2		1				1		
CO 3	1				2		1				1		
CO 4	1		1		2		1				1		
CO 5	1				2		1				1		
CO 6			2		1		1		1		2		

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓		✓
CO6	✓	✓	✓	

FOUR-YEAR UNDER GRADUATE

PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	**BASIC INORGANIC AND BIO-INORGANIC CHEMISTRY**				
Type of Course	**MINOR**				
Semester	**I**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
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Pre-requisites	Concept of atom and molecule Constituents of the atom, Rutherford's model of the atom. Periodic table and classification of elements to different blocks, Basic knowledge of qualitative and quantitative analysis Titration and use of indicators				
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Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	**To Understand the structure of atoms and rules regarding the arrangement of electrons in an atom.**	U	C	Instructor-created exams / Quiz
CO2	**To discuss the chemical bonding, theories of chemical bonding and predict molecular shapes using VSEPR theory**	U	F	Class test /Assignment / Quiz

CO3	**To Comprehend periodic properties, understand laws and the concept of the modern periodic table, and its implications**	U	F	Class test /Assignment / Quiz
CO4	**To Master the principle of volumetric analysis, understand the separation of cations in qualitative analysis**	U	C	Class test /Assignment / Quiz
CO5	**To Explain roles of metal ions in biological systems and understand the biochemistry of certain key elements**	U	F	Class test /Assignment / Quiz
CO6	**To Perform different titrations and execute open-ended experiments safely and effectively**	Ap	P	Lab work
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		**Atomic structure and Chemical Bonding**	**15**	**34**
	1	Bohr atom model, merits and its limitations, Heisenberg uncertainty principle, Louis de Broglie's matter waves – dual nature.	2	
	2	Schrödinger wave equation (Mention the equation and the terms in it), - Concept of orbitals, comparison of orbit and orbital.	2	
	3	Quantum numbers and their significance	1	
	4	Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms.	2	
	5	Chemical Bonding: Introduction – Type of bonds. Ionic bond, Covalent bond, Coordinate bond, and hydrogen bond (Intermolecular and intramolecular hydrogen bond with examples).	2	
	6	VSEPR theory: Shapes of $BeCl_2$, BF_3, CH_4, NH_3, H_2O, PCl_5, SF_4, ClF_3, XeF_2, SF_6, IF_5, XeF_4, IF_7 and XeF_6. NH_4^+, SO_4^{2-}	2	
	7	Valence Bond theory - Hybridisation involving s, p and d orbitals: SP (acetylene), SP^2 (ethylene), SP^3 (CH_4), SP^3d (PCl_5), SP^3d^2 (SF_6)	2	
	8	Molecular Orbital theory: LCAO – Electronic configuration of H_2, B_2, C_2, N_2, O_2 and CO – Calculation	2	

		of bond order and its applications.(Bond length and bond strength), Comparison of VB and MO theories		
II		**Periodic Properties**	**5**	**10**
	9	Name and symbol of elements, Law of triads, octaves, X-ray studies of Henry Mosley, Moseley's periodic law - Modern periodic law – Long form periodic table.	**2**	
	10	Periodicity in properties: Atomic and ionic radii, Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity, valency, Oxidation number (Representative element), metallic and non-metallic character, inert pair effect,	**3**	
III		**Analytical Chemistry**	**15**	**34**
	11	Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Equivalent mass.	**2**	
	12	Methods of expressing concentration: Molality, molarity, normality, ppm, and mole fraction.	**2**	
	13	Dilution formula, Theory of volumetric analysis – Acid-base, redox, and complexometric titrations :	**3**	
	14	acid-base, redox, and complexometric indicators. Double burette method of titration: Principle and advantages.	**2**	
	15	Principles in the separation of cations in qualitative analysis	**2**	
	16	Common ion effect and solubility product and its applications in qualitative analysis –	**2**	
	17	Microanalysis and its advantages. Accuracy & Precision (mention only).	**2**	
IV		**Bio-inorganic Chemistry**	**10**	**20**
	18	Metal ions in biological systems - Biochemistry of iron, Haemoglobin and myoglobin,	**2**	
	19	O_2 and CO_2 transportation (mechanism not required) - Chlorophyll and photosynthesis (mechanism not expected)	**2**	
	20	Elementary idea of structure and mechanism of action of sodium potassium pump	**2**	
	21	Biochemistry of zinc and cobalt. Toxicity of metal ions (Pb, Hg and As).	**2**	
	22	Anticancer drugs: *Cis*-platin, oxaliplatin,– Structure and significance.	**2**	
		Basic Inorganic Chemistry Practical: **Acid-Base titrations and Redox titrations**	**30**	

		General Instructions For weighing electronic balance must be used. For titrations, double burette titration method should be used. Standard solution must be prepared by the student. Use a safety coat, gloves, shoes and goggles in the laboratory. A minimum of 7 experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher		
		Importance of lab safety – Burns, Eye accidents, Cuts, gas poisoning, Electric shocks, Treatment of fires, Precautions and preventive measures. Weighing using electronic balance, Preparation of standard solutions.		
	I	**Neutralization Titrations** 1. Strong acid – strong base. 2. Strong acid – weak base. **3.** Weak acid – strong base.		
V	II	**Redox Titrations - Permanganometry:** 4. Estimation of oxalic acid. 5. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt **Redox Titrations - Dichrometry** 6. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using internal indicator. 7. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using external indicator. **Redox Titrations - Iodimetry and Iodometry:** 8. Estimation of iodine. **9.** Estimation of copper		
	III	**Open-ended experiments - Suggestions** Iodometry: Estimation of chromium. Determination of acetic acid content in vinegar by titration with NaOH. Determination of alkali content in antacid tablets by titration with HCl. Determination of available chlorine in bleaching powder.		

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7. G. L. Meissler, D. A. Tarr, *Inorganic Chemistry*, 3rd Edn. Pearson Education, 2004.

8. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic Chemistry*, 5th Edn., Pearson, 2009.

9. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.

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Mapping of COs with PSOs and POs:

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	**2**				**2**		**1**				**1**		
CO 2	**2**				**2**		**1**				**1**		
CO 3	**1**				**2**		**1**				**1**		
CO 4	**1**		**1**		**2**		**1**				**1**		
CO 5	**1**				**2**		**1**				**1**		
CO 6			**2**		**1**		**1**		**1**		**2**		

Correlation Levels :

Level	Correlation
0	Nil
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Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓		✓
CO6		✓	✓	

FOUR-YEAR UNDER GRADUATE

PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

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Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	**To Understand the structure of atoms and rules regarding the arrangement of electrons in an atom.**	U	C	Instructor-created exams / Quiz
CO2	**To discuss the chemical bonding, theories of chemical bonding and predict molecular shapes using VSEPR theory**	U	F	Class test /Assignment / Quiz

CO3	**To Comprehend periodic properties, understand laws and the concept of the modern periodic table, and its implications**	U	F	Class test /Assignment / Quiz
CO4	**To Master the principle of volumetric analysis, understand the separation of cations in qualitative analysis**	U	C	Class test /Assignment / Quiz
CO5	**To Comprehend the process in metallurgy including extraction of metals and alloy formation**	U	F	Class test /Assignment / Quiz
CO6	**To Perform different titrations and execute open-ended experiments safely and effectively**	Ap	P	Lab work
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	2	Schrödinger wave equation (Mention the equation and the terms in it), - Concept of orbitals, comparison of orbit and orbital.	2	
	3	Quantum numbers and their significance	1	
	4	Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms.	2	
	5	Chemical Bonding: Introduction – Type of bonds. Ionic bond, Covalent bond, Coordinate bond, and hydrogen bond (Intermolecular and intramolecular hydrogen bond with examples).	2	
	6	VSEPR theory: Shapes of $BeCl_2$, BF_3, CH_4, NH_3, H_2O, PCl_5, SF_4, ClF_3, XeF_2, SF_6, IF_5, XeF_4, IF_7 and XeF_6. NH_4^+, SO_4^{2-}	2	
	7	Valence Bond theory - Hybridisation involving s, p and d orbitals: SP (acetylene), SP^2 (ethylene), SP^3 (CH_4), SP^3d (PCl_5), SP^3d^2 (SF_6)	2	
	8	Molecular Orbital theory: LCAO – Electronic configuration of H_2, B_2, C_2, N_2, O_2 and CO – Calculation of	2	

		bond order and its applications.(Bond length and bond strength), Comparison of VB and MO theories		
II		**Periodic Properties**	**5**	**10**
	9	Name and symbol of elements, Law of triads, octaves, X-ray studies of Henrry Mosley, Mosleys periodic law - Modern periodic law – Long form periodic table.	**2**	
	10	Periodicity in properties: Atomic and ionic radii, Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity, valency, Oxidation number (Representative element), metallic and non-metallic character, inert pair effect,	**3**	
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	11	Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Equivalent mass.	**2**	
	12	Methods of expressing concentration: Molality, molarity, normality, ppm, and mole fraction.	**2**	
	13	Dilution formula, Theory of volumetric analysis – Acid-base, redox, and complexometric titrations :	**3**	
	14	acid-base, redox, and complexometric indicators. Double burette method of titration: Principle and advantages.	**2**	
	15	Principles in the separation of cations in qualitative analysis	**2**	
	16	Common ion effect and solubility product and its applications in qualitative analysis –	**2**	
	17	Microanalysis and its advantages. Accuracy & Precision (mention only).	**2**	
IV		**Metallurgy**	**10**	**20**
	18	Ores and minerals, Concentration of ores – Calcination and roasting – Reduction to free metal.	**2**	
	19	Electrometallurgy – Hydrometallurgy. Refining of metals: Electrolytic refining, zone refining	**2**	
	20	Extractive metallurgy of Al, Fe	**2**	
	21	Alloys: Definition – Composition and uses of German silver, brass, bronze, gunmetal and alnico. Steel: Open hearth process (brief description only)	**2**	
	22	Classification of steel – Composition and uses of stainless steels, and applications of industrially important stainless steel types- (AISI Grade mention only)	**2**	
		Basic Inorganic Chemistry Practical: **Acid-Base titrations and Redox titrations**	**30**	

		General Instructions For weighing electronic balance must be used. For titrations, double burette titration method should be used. Standard solution must be prepared by the student. Use a safety coat, gloves, shoes and goggles in the laboratory. A minimum of 7 experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher		
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	I	**Neutralization Titrations** 1. Strong acid – strong base. 2. Strong acid – weak base. **3.** Weak acid – strong base.		
V	II	**Redox Titrations - Permanganometry:** 4. Estimation of oxalic acid. 5. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt **Redox Titrations - Dichrometry** 6. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using internal indicator. 7. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt using external indicator. **Redox Titrations - Iodimetry and Iodometry:** 8. Estimation of iodine. **9.** Estimation of copper		
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7. A. Cottrel, *An introduction to metallurgy*, 2nd Edn., University press, 1990.

8. Jonathan Beddoes, J. Gordon Parr, *Introduction to stainless steels*, 3rd Edn., ASM International, 1999.

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	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2				2		1				1		
CO 2	2				2		1				1		
CO 3	1				2		1				1		
CO 4	1		1		2		1				1		
CO 5	1				2		1				1		
CO 6			2		1		1		1		2		

Correlation Levels :

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓		✓
CO6		✓	✓	

FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	**ENVIRONMENTAL CHEMISTRY**				
Type of Course	**MDC**				
Semester	**I**				
Academic Level	**100-199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	What is Environment. Basic idea of environmental pollution.				
Course Summary	This course ensures that the students acquire a profound knowledge and understanding on environmental pollution and the necessity of controlling environmental pollution.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Acquire the knowledge on ecosystem.	**U**	**C**	Instructor-created exams / Quiz
CO2	Recall the technical/scientific terms involved in pollution.	U	C	Instructor-created exams / Quiz
CO3	Recognize different types of toxic substances that cause environmental pollution.	U	C	Instructor-created exams / Assignment
CO4	Understand the effects of environmental pollution.	U	C	Seminar Presentation / Viva
CO5	Understand various pollution control measures.	U	C	Instructor-created exams / Quiz
CO6	Discuss and report local and global environmental issues based on the knowledge gained throughout the course.	Ap	P	Group discussion and Seminar presentation/Viva

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs	Mark
I		**Introduction to Environmental Chemistry**	**9**	**18**
	1	Environmental segments-Atmosphere, Hydrosphere, Lithosphere, Biosphere	2	
	2	Interaction between different environmental spheres Concept of ecosystem, abiotic and biotic components	2	
	3	Composition of Air, Water and Soil	2	
	4	Environmental pollution – Concepts and definition – Pollutant, contaminant, receptor and sink	1	
	5	Classification of pollutants – Global, regional, local, persistent and non-persistent pollutants.	1	
	6	Types of pollution	1	
II		**Air Pollution**	**9**	**18**
	7	Tropospheric pollution – Gaseous air pollutants – Hydrocarbons, oxides of sulphur, nitrogen and carbon (Elementary idea only)	2	
	8	Global warming, green house effect, acid rain	1	
	9	Particulates – Smog: London smog and photochemical smog –	2	
	10	stratospheric pollution - depletion of ozone layer, chlorofluorocarbons - Automobile pollution.	2	
	11	Control of air pollution	2	
III		**Water Pollution**	**10**	**20**
	12	Impurities in water – cause of pollution – natural and anthropogenic – Marine water pollution – Underground water pollution.	1	
	13	Source of water pollution – Industrial waste, Municipal waste, Agricultural waste, Radioactive waste, Petroleum, Pharmaceutical, heavy metal, pesticides, soaps and detergents.	2	
	14	Types of water pollutants: Biological agents, physical agents and chemical agents – Eutrophication- biomagnification and bioaccumulation.	2	
	15	Water quality parameters: DO, BOD, COD, alkalianity, hardness, chloride, fluoride and nitrate. Toxic metals in water and their effects: Cadmium, lead and oil pollution in water.	3	
	16	Water pollution control methods	2	

IV	**Soil, Thermal, and Radioactive Pollutions**		**8**	**14**
	18	Soil pollution: Sources by industrial and urban wastes. Non-degradable, degradable and biodegradable wastes. Hazardous waste.	2	
	19	Pollution due to plastics, pesticides, biomedical waste and *e-waste* (source, effects and control measures) – Control of soil pollution - Solid waste Management – Open dumping, Landfilling, Incineration, Re-use, reclamation, recycle, composting.	3	
	20	Thermal pollution – definition,sources, harmful effects and prevention.	1	
	21	Radioactive pollution (source, effects and control measures) – Hiroshima, Nagasaki and Chernobyl accidents (brief study).	2	
V	**Open Ended Module: Environmental issues**		**9**	
	1	Environment and society Pollution case studies: Chernobyl disaster, Bhopal tragedy, Endosulfan disaster in Kerala (brief study) etc.		

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Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	1	1	1			2	1		
CO 2	1		-	-	1	1	1			1	1	1	1
CO 3	-	-		1	2	2	1			2	2	1	
CO 4	-	-			1	2	1			1	1	1	1
CO 5	-		-	1	2	2	1			1		1	1
CO 6	-	-	-	1	2	2	1			1	1	1	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/viva	Quiz/seminar/ Goupdiscussion	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓		✓	✓
CO 3	✓	✓		✓
CO 4		✓	✓	✓
CO 5	✓		✓	✓
CO 6		✓	✓	